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Research Report

Flanders as a creative innovative region

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June 2011

FLANDERS DISTRICT OF CREATIVITY

Flanders DC is the **Flemish organisation for entrepreneurial creativity** and was established by the Flemish Government in 2004. Flanders DC's mission is **to make enterprising Flanders more creative and to make creative Flanders more entrepreneurial**.

Flanders DC builds **knowledge**, raises **awareness** and designs **practical tools** for anyone wishing to launch a creative and enterprising project. To this end Flanders DC established a **Knowledge Centre** at Vlerick Leuven Gent Management School and the Antwerp Management School. Research themes include: innovation, intra/entrepreneurship, internationalisation and the creative industries.

Flanders DC focuses on **entrepreneurs, teachers, students, policy-makers and the general public**. Among the many options Flanders DC offers are: a free online training in creative thinking, a creativity test, a brainstorm kit, invite an entrepreneur to speak in your class or at your event, take part in the De Bedenkers (The Inventors) classroom competition and an online game to discover how you score as an innovative manager.

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Flanders DC believes that creativity and innovation originate in new combinations. Flanders DC therefore wants to be a **networking platform** where various initiatives, companies and regions can easily find one another. In this way Flanders DC aims to facilitate fast and new combinations between players in different domains.

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- **Ondernemen.meerdan.o**ndernemen, an online learning platform
- **Creativity Class** for young high-potentials
- **Flanders DC Fellows**, inspiring role models in business creativity
- **Creativity Talks**, monthly seminars on business creativity and innovation
- **Innovix**, online innovation management game
- **Flanders DC Academic Seminars**, research seminars on business creativity and innovation
- **TeamScan**, online tool
- **Web 2.0 Readiness Scan**
- **HR Toolbox**
- **Product Leadership Toolkit**

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1 Introduction

A recent OECD report (OECD 2009) “Regions Matter” illustrates how regions grow in very varied ways. A key finding of the report is that the concentration of resources in a region is not sufficient for long-term growth. The report underlines that the way investments are made, regional assets are used and synergies exploited account for substantial difference in growth performance across regions. Hence, opportunities for growth exist in all types of regions, but actual growth performance will depend on how well the region is capable of mobilizing its assets to make full use of its potential growth. Differences in performance across regions cannot solely be explained by differences, and their growth over time, in the quantity and quality of productive factors in different regions. Conventionally, these productive factors are human capital, physical capital and natural endowments (which can include natural resources as well as elements such as climate).

In this paper we argue that the unexplained variation across regions is related to the (imperfect) working of three creative processes: innovation, impact entrepreneurship, i.e. new firms creating jobs, and internationalization. There is indeed growing evidence that each of these creative processes is strongly associated with economic growth, but also that these processes are endogenous and to a large extent dependent on the political and economic systems that differ across countries and regions (Hill, 2011).

While the differences in regional development patterns are recognized, many “old industrialized” regions in Europe are facing important challenges. The ageing of the population, environmental pressure, rapid emergence of new “distant” economic powers call for action. At the same time, new trends in industrial management and technology offer new creative opportunities that make it possible for firms to benefit from changes in the global environment. An increasing number of firms develop a strong competitive position on the world market through spreading their activities across national borders and by co-creating new products and services with suppliers, customers, knowledge institutions and increasingly, with the creative sector (Verganti, 2009). The combination of these developments has given rise to a new paradigm in the development of new business models. This new paradigm puts creativity central in the development of sustainable production and consumption patterns for the future.

Creativity is also what makes people, firms and regions unique. It is the capability to find innovative solutions to problems, to create new products or processes, to set up new firms and to expand into new areas that creates economic value. As such, creativity should be linked to innovation and entrepreneurship in order to guarantee its translation into market opportunities. In the context of a globalizing economy many regions and countries are no longer able to compete in their traditional sectors on the basis of cost minimization or productive efficiency. Firms redefine their economic strategy to find new sources of competitive advantage, and in this entrepreneurial creativity has become a major focus. The entrepreneurial orientation of firms has indeed become a key factor in successfully competing on world markets (Lumpkin, G.T., Dess, G.G. 1996).

Entrepreneurial creativity is therefore best seen as a combination of innovation, entrepreneurship and internationalization. As will be illustrated in this paper, successful creative regions which offer firms favorable conditions to develop entrepreneurial creativity grow into important nodes of global knowledge and production networks and generate clusters of related activities that offer new channels for growth.

In this paper we focus on regional entrepreneurial creativity and investigate the pillars, or underlying basic conditions, that are essential to direct resources toward a creative use and generate growth. The

emphasis will be on innovation as one of the fundamental creative processes. After defining the key concepts and the conceptual model of creative regional development in section 2 and 3, a set of statistical indicators is developed in section 4. Using these indicators, the model is tested against the innovation performance of a wide set of European regions, following the NUTS-1 classification in section 5. The testing and interpretation of the results is followed by a case study of the Leuven region in Flanders, Belgium, which illustrates how the creativity pillars direct and sustain the creative processes of innovation but also stimulate the creative processes of entrepreneurship and internationalization. The resulting development of strong technology based clusters is key in the development of the region. The paper concludes with some policy recommendations.

2 The innovative region: a brief literature review

Each region has specific assets, unique capabilities and industrial policies that make it different from other regions. According to the OECD study (2009) national contextual factors are important for regional growth, but are a necessary and not sufficient condition. The regional specific assets and policies are what define the relevant sustainable growth path and performance of the regions. As Cornett underlines, regional growth is an *endogenous* phenomenon, and therefore policy-makers need to take this into consideration in designing policies to foster knowledge dissemination, innovation and local entrepreneurship (Cornett 2009). More fundamentally, policies should be targeted to direct and sustain the creative processes of innovation, entrepreneurship and internationalization by firms operating or attracted to the region. While all three creative processes are necessary to generate growth, innovation is increasingly gaining importance in driving the system.

Innovation plays a key role in the growth process: innovation does not only lead to productivity gains and an improved economic performance, but also to an improvement of the social well-being and environmental sustainability. However, innovation is not evenly distributed among regions. The differences in regional innovation capacity can largely explain the differences in innovation performance and to a large extent the differences in regional growth (see for example Doloreux and Parto 2008 on the innovation capabilities of Canadian peripheral regions). [1]

With innovation becoming the focal point in the development discourse, several approaches have been advanced in the literature explaining how the regional innovation process works. The first approach is the so-called “linear model” (Bush 1945, Maclaurin 1953). In this framework a linear relationship is drawn between basic research, applied research, innovation and ultimately growth. This approach received in the past quite some criticism (Rosenberg 1994), but despite this many scholars and policy makers still use it and refer to it, as it as a straightforward representation of the regional innovation process. However, this model completely ignores the contextual determinants of research, development and growth. Innovation is indeed a process that unfolds in a specific area and depends on the socio-economic and institutional context in which it develops.

A second group of theories takes structural factors that characterize each economic system into consideration and tries to explain how and under which conditions innovation can take place in a certain area. Concepts like the “system of innovation” (Lundvall 1992), “regional system of innovation” (Cooke et al, 1997; Enright, 2001) and “learning region” (Morgan 1997, Gregsen and Johnson 1996) underline the importance of the territorial dimension, the institutional framework and specific set and combination of conditions of a territory. The capacity of the territory to be a catalysts for innovation depends, according to Rodriguez-Pose (1999), on the combination of social and structural conditions in every territory, which they call “social filter”.

A major drawback of these studies is the absence of a common unit of analysis and a focus on different concepts. The “innovative milieu” (Camagni 1995), the “industrial district” (Becattini 1987), the “learning region” (Morgan 1997) and the “system of innovation” (Cooke 1998) are concepts developed at different geographic scales, being it the city (Camagni 2001), the metropolitan region (Diez 2002), the district (Porter 1998, Enright 2001) or the NUTS region (Evangelista et al 2002, RIS – Regional Innovation Scoreboard 2009). Iammarino (2005) recognizes these limitations and introduces a sort of

[1] Doloreux, D., & Dionne, S. (2008). Is regional innovation system development possible in peripheral regions? Some evidence from the case of La Pocatière, Canada. Entrepreneurship & Regional Development, 20(3), 259-283.

meso-level of analysis, which blends the national system of innovation with the influences of local regional conditions within an “evolutionary integrated view of the regional system of innovation”.
The system approach puts great emphasis on the interactions between public and private actors to guide and sustain innovation, related to the “triple helix paradigm”. The latter conceptual approach highlights the crucial role of effective cooperation between political decision makers, academia and firms in fostering regional innovation.

If the second group of theories looked mainly at the way in which innovation develops, a third group of theories aims at understanding how innovation is spread and disseminated. An important role is played by proximity, local synergies and interaction among the actors in the regional system (Camagni 1995, Vaz and Nijkamp 2009). The so-called “knowledge spillovers approach” (Jaffe 1986, Audretsch and Feldman 1996, Cantwell and Iammarino 2003, Sonn and Storper 2005) focuses on the importance of integrating the local context and local networks with global networks.
Networks provide interactions that generate knowledge spillovers that are beneficial for the various actors participating in the network (Nightingale 1998, Gertler and Wolfe 2004). However, many authors have emphasized the importance of firms having an absorptive capacity as an essential condition to translate knowledge spillovers into the generation of new technologies. Arndt and Sternberg (2000), for instance develop a “multilevel model” of knowledge creation and knowledge use in which networks foster knowledge circulation, with sustainable development as the final goal. The growing relevance of networks and connectivity for effective innovation was also recently restated by the OECD (OECD 2011).

Summarizing the above literature, three main characteristics are common to the system theories alternative to the linear model (Rodriguez-Pose and Crescenzi 2008). First, innovative efforts have to be regionally driven. Without regional policies taking into consideration the local specificities, innovation cannot be effective. According to Cornett, for example, regional growth is an endogenous phenomenon. In his view policy makers need to focus on the local factors facilitating growth and stimulate innovative behaviors and entrepreneurship (Cornett 2009). Policies tailored on conditions that are specific to the area are more effective and can for example turn a disadvantage into an advantage (ie administrative reforms)(OECD 2011). Cornett calls it “regional filtering process”, the capability to use the most appropriate policy instruments in a particular context. A common pitfall in traditional regional policy was the “one size fits all” approach where regions were copying each other initiatives and developing the same kind of technologies or industries. The new approach puts more emphasis on bottom-up initiatives and the development of open innovation systems inviting all private and public partners to work and to govern together the regional system. Within this approach the effectiveness of policies is continuously monitored and, if necessary, adapted to new regional realities.

Second, knowledge spillovers from being part of a network are important if not necessary to increase the innovation potential. Being part of a network is significant for firms as they can benefit from tacit communication and sharing different capabilities and competences within the network. Many studies have analyzed networks from different perspectives. A recent study of Besser and Miller (2011), assesses the factors that contribute to the success of networks. Empirical evidence of the increased innovation performance of firms that are part of a network is presented in the paper of Huggins and Johnson (2010). Tolstoy (2010) argues that networks provide opportunities for exploiting new combinations of knowledge both in the home market and in foreign markets. His work, based on surveys on a random sample of 188 Swedish SMEs, shows that networks have a positive impact on knowledge creation and knowledge combination, triggering a positive innovation cycle. Networks have also been studied from different angles and perspectives. For instance, Sotarauta (2010) analyses how to create, direct and maintain networks, Björk and Magnusson (2009) study the links between networks and the quality of firms’ innovation, Phelps (2010) investigates the influence of networks on exploratory innovation.

The third and maybe most important common characteristic is the recognition of the importance of the social, cultural and informational territorial embeddedness of innovation. Innovation is context-dependent: it happens in communities that share a common knowledge base. Tacit knowledge (as defined by Nightingale in 1998 and Kaiser in 2002) is the "system of common assets and positive contributions for productive processes that are spatially located". Within this perspective sustainable competitive advantage can only come from investing in local specialized assets (Porter 1998, Asheim et al 2003).

In the next section we use the insights from the literature in the development of our own conceptual model of regional development, which emphasize the key role of entrepreneurial creativity for the generation of economic growth.

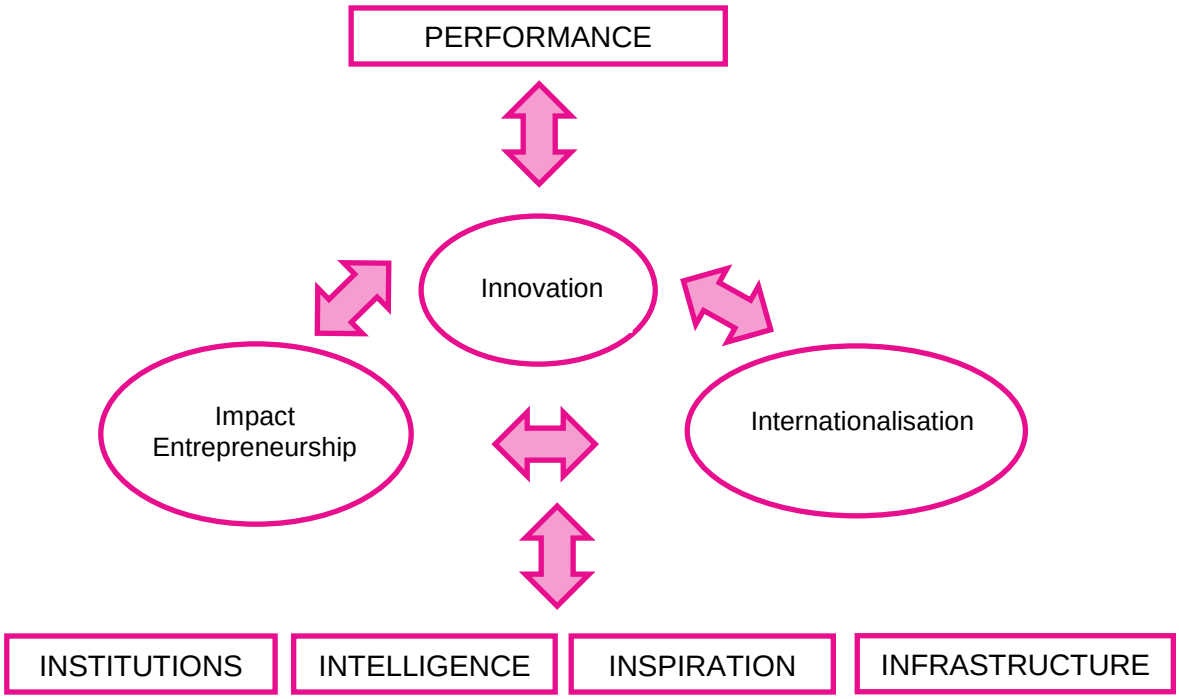
3 A model of creative regional development

The model of creative regional development is based on the observation that regional development goes hand-in-hand with the functioning of three interactive creative processes: entrepreneurship, innovation and internationalization. The model emphasizes that a positive response to new growth opportunities can only be achieved through an integrated policy approach focused on the basic elements, i.e. pillars of the system that direct and sustain the three processes. The approach follows from systemic analysis of the regional economy and links the interactions between the creative processes to policy-sensitive basic conditions. Different from previous work, this paper uses system theory to mark a clear hierarchy among the elements and the processes that make the system evolve. The focus is on validating the basic elements, or fundamental conditions that direct and sustain the creative processes.

Particularly, it is argued that the direction and functioning of the creative economic processes in a region depend on four basic conditions, the so-called 4i factors: Institutions, Intelligence, Inspiration and Infrastructure. Those conditions interact with the elements of the regional system and determine the way it performs. Other elements such as the number of firms and the type of activities making up the system are considered to be intermediate elements.

The model is graphically represented in **Figure 1**.

Figure 1: A model of creative regional development



The model puts all emphasis on the three creative processes that lead to new combinations of products, markets, and firms: innovation (new products and processes), internationalization (new markets) and impact entrepreneurship[2] (new firms creating jobs). The direction and intensity of the creative processes depend on the 4i factors that are to a large extent shaped by policies at regional, national or supranational level. However, the feedbacks from the creative processes to the four basic conditions require a continuous updating and revision of existing policies.

The importance of the basic conditions can hardly be overestimated. They are the fundamental drivers of the regional system of growth, even acknowledging for the fact that the regional economic system is embedded in national and global systems. The degree of integration determines the level of interdependence in the system; an interdependence that should be taken into account in developing the pillars.

INSTITUTIONS

The first of the four basic conditions, institutions is taken in its broadest sense and comprises political, economic and social institutions. The role of institutions for economic development is receiving increasing attention in the literature. Institutions have a deep impact on all of three creative processes. Institutions shape all economic, political and social interactions, or as North (1990, p. 3) put it: "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction". Economic institutions comprise property rights, contract enforcement, laws and rules that shape economic incentives, contracting possibilities and determine the distribution of income.

[2] Zoltan Acs defines impact entrepreneurship as "the actions of individuals responding to market opportunities by bringing inventions to the market that create wealth and growth. These entrepreneurs are distinct from mere creators of new firms, those that replicate thousands of other establishments" (Acs, 2008).

Political institutions put constraints on politicians behavior and elites, determine the separation of power, shape political incentives and distribution of political power. Social institutions, formal or informal, regulate interactions among people in work and non-work environments. As widely documented, there are substantial differences in economic and political institutions across countries and regions. In the literature a strong enforcement of property rights, democratic regimes and an absence of corruption are considered as key elements to foster entrepreneurial creativity, innovation and international exchanges with other countries or regions (Hill, 2009). This explains why business leaders usually asses the quality of institutions in terms of the stimulating or hindering impact they exercise in relation to the three creative processes (see next section).

In a recent paper Tebaldi and Elmslie[3] (2008) present empirical evidence on the links between innovation and institutions. Using a large set of cross-country data, the study finds that institutional arrangements explain much of the variation on patent production across countries. They identify how control of corruption, market-friendly policies, protection of property rights and a more effective judiciary system "boost" the rate of innovation.

Interestingly, the study finds that, controlling for institutional quality, geographic-related variables are not significant in explaining patent production. This paper also presents evidence that in the long-run human capital accumulation is an important variable in shaping institutions.

INTELLIGENCE

The second pillar, intelligence, is defined as the scope and quality of education.
Holbrook and Clayman (2003) emphasize that tertiary education plays an important role in generating innovative skills and research that feed enterprises in the particular region. Knowledge created at universities and (professional) colleges is essential to develop the needed skills and expertise, and also allows companies to access state of the art labs and capable graduates.
There is a growing interaction between the educational system and the private sector in generating basic and applied research. The interaction with the technology infrastructure is crucial in that respect.

Wolfe (2004) observes that universities are under pressure to generate more applied knowledge of greater relevance to industry and to diffuse knowledge, much influenced by the political expectation that the educational system and public research funding should contribute substantially to local and regional economic development. Against a set of EU25 regions analyzed over 1995–2003, Rodríguez-Pose and Crescenzi (2006) demonstrated the importance of a 'social filter' indicator, along with the initial level of GDP and the intensity of R&D expenditure, to explain the innovative performance of regions. The indicator was extracted, through a principal component analysis, from a set of variables including the shares of population and labor force with tertiary education and the rate of involvement in life-long learning. Their evidence supports the basic idea that the regional capability to translate knowledge into innovation and economic growth is shaped by a social filter. They found that regions with a weak (strong) social filter are likely to be 'averse' ('prone') to innovation.

INSPIRATION

The third pillar, inspiration, is an important factor not only because the presence of creative people is important as an input factor , but also because many studies have shown that creative people are attracted to a certain region by the presence of other individuals with the same creative attitude.

[3] Tebaldi, Edinaldo and Elmslie "Do Institutions Impact Innovation?" BruceMPRA Paper No. 8757, Munich, 2008.

Richard Florida sees the creative class as the driving force for economic development. In his book "The rise of the creative class" Florida describes an emerging segment of the U.S society, made up of knowledge workers, intellectuals, artists and bohemians. These people have a preference for creative jobs in technological sectors, R&D, cultural industries and knowledge-intensive services. Cities or regions emphasizing talent, tolerance and technology will benefit from agglomeration economies and attract creative reorganizations and high tech firms to the area. Florida (2002) suggests that technology alone is not going to create prosperity. Also needed is the kind of creative entrepreneurs who can translate great ideas into sustainable business models. It is essential therefore not only to attract creative people but to also tap into those professions that are not commonly perceived as creative. Key elements for achieving this are the creation of a general climate of openness and the fostering of immigrant-rich, creative urban areas.

The creative industry has itself become an important source of economic growth (see e.g. The Work Foundation 2007[4], Flanders DC 2007) and an increasingly important source and facilitator of innovations. The boundaries between creative industries and other industries are indeed increasingly blurring. In a recent study Bakhshi and McVittie (2009) have examined the innovation contribution of firms in creative industries to firms in the wider economy. Potts (2009) has developed a model detailing the role of creative industries in relation to an innovation trajectory, consisting of the origination, adoption and retention of a new idea or technology. In each of the three phases the creative industries provide distinct "creative innovation services" in helping the system to move following a new evolutionary track.

INFRASTRUCTURE

The fourth and last pillar is infrastructure. While all elements of infrastructure taken in its broadest sense (roads, energy grids…) play a role in fostering regional growth, for the purpose of this analysis there is the need to focus on infrastructures dedicated to innovation. The term "innovation infrastructure" has been used in many different ways in the literature, including all kinds of knowledge institutions, network configurations, financial support institutions and government involvement. The problem of using the concept in this way is that it is too broad and overlaps with the other basic conditions of our system. For the purpose of our analysis a definition that distinguishes itself from the other three conditions is needed. A definition that fits with this purpose is the definition of "technological infrastructure"[5]: "research labs, universities and industries connected via a fast and reliable communication network". Increasingly such infrastructures have been associated with the emergence of Science and Technology Parks.6 (Zhao 2000).
Kavoos Mohannak (2008) sees the following general characteristics of technological infrastructures which he labels as "smart innovation infrastructures":

- "a physical property, often laid out like a park, to which new or existing research-based small or larger companies are attracted by the working conditions, the physical proximity of a university or a research institute or simply by the pleasant nature of the area.
- managed by specialized professionals, whose main aim is to increase the wealth of their community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions.
- The principal purpose of park/precinct is to deal with innovation in terms of research, development and design, conceiving new products and developing them to the marketing stage. The research and development (R&D) work conducted by firms in the precincts is often limited to designing prototypes, while the manufacturing side of the business is located

[4] The Work Foundation (2007). *Staying ahead: the economic performance of the UK's creative industries.* Report commissioned by the Department of Culture, Media and Sport, UK.
[5] Definition retrieved from the Business Dictionary Online.
[6] Zhao, F. *University-industry partnerships in Australia: a strategic perspective*. Centre for Management Quality Research.

elsewhere, though some firms do engage in the production of one-off sophisticated items, and some parks do have manufacturing facilities."[7]

Public R&D spending has been very instrumental in the development of high level technological infrastructures, and in fostering the triple helix: government, industry and science (Zhao, 2000).

"Smart Innovation infrastructures" also includes all kind of software that makes networking within and outside the boundaries of an organization possible. New mechanisms in "soft innovation" (Stoneman 2007) improve the efficacy of new digital and media technologies and facilitate "open innovation" systems between participating actors (Shirky 2008; Leadbeater 2008). Organized networks of knowledge exchange among all actors involved in the creation and diffusion of new innovations are critically important in this respect. See for example the increasing popularity of "open innovation" systems, where the presence of diverse partners involved in the development of new innovations is crucially important, but also the development of an efficient virtual network by means of an efficient "physical" communication network. If a well-developed ICT and broadband infrastructure are both present in a region they can generate positive impacts, both direct and indirect. The direct impacts are those that are generate by the direct investments in this type of infrastructure. Indirect impacts are the network spillover effects generated by this kind of infrastructural investments. A recent OECD (OECD 2007)8 report lists some of them, including firm efficiency and increased productivity, reduced costs, innovation, globalization, and new employment opportunities.

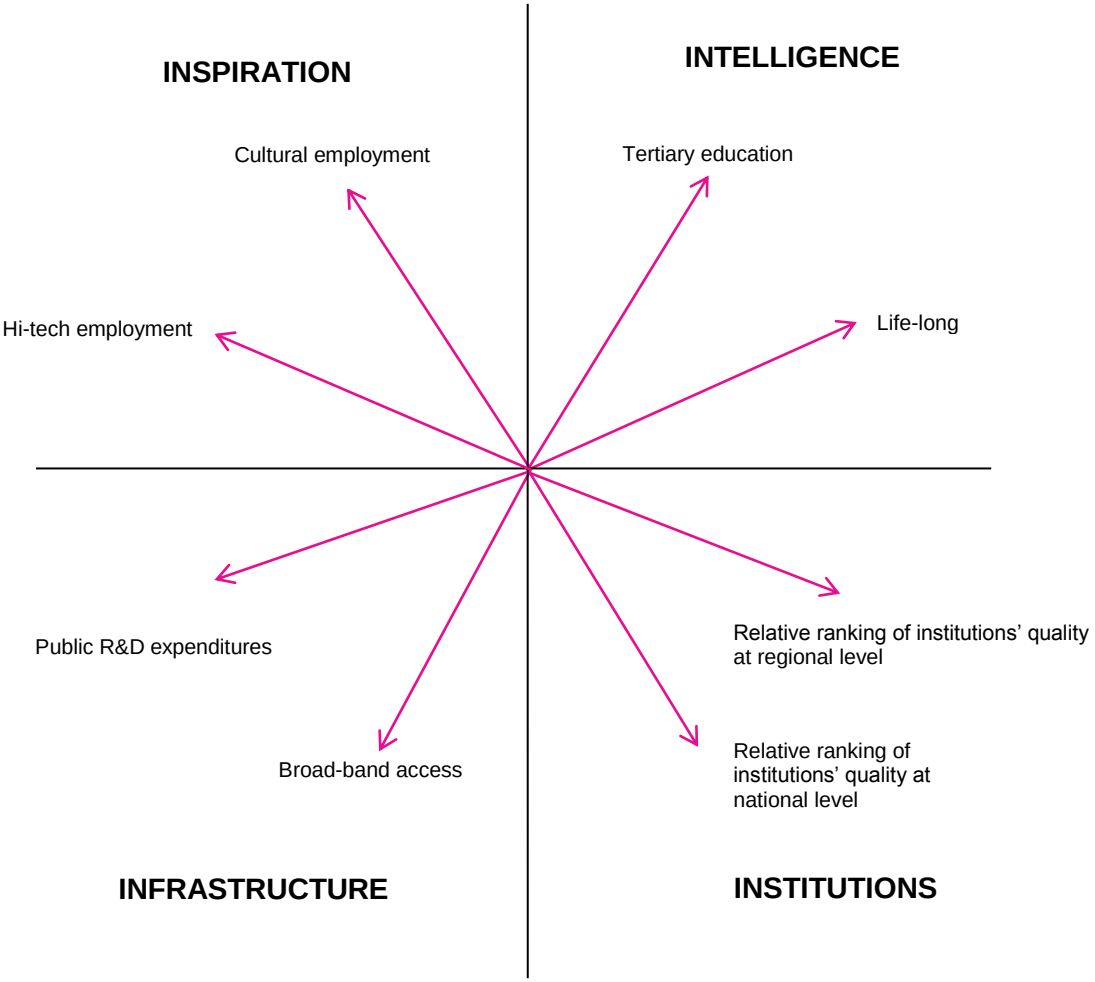
In fact the increasing diffusion of the broadband has a positive impact on the economy, through supporting the emergence of new business models, new processes and increasing the competitiveness and the flexibility in the economy (OECD 2007).New products – both goods and services – are increasingly created thanks to and in line with ICT developments. The European Commission also recognized the importance of ICT to foster innovation and economic growth. It drawn the so called "Digital Agenda", in which ICT, internet and broadband networks are seen as enablers of innovation, business development and ultimately economic growth.[9]

[7] Mohannak, K. (2008). *Role of the techno parks in clustering of high technology SMEs*. In: EuroMOT: the 3rd European Conference on Technology Management, 17–19 September 2008, Nice, France.
[8] OECD (2008). *Broadband and the economy*, Ministerial Background Report DSTI/ICCP/IE(2007)3/FINAL OECD Ministerial Meeting of the Future of the Internet Economy, Seoul, Korea.
[9] European Commission (2010). *A Digital Agenda for Europe.* COM(2010) 245, Brussels.

4 Statistical indicators of creativity pillars

The 4i – institutions, intelligence, infrastructure, inspiration – constitute the 4 pillars that support the innovation-entrepreneurship-internationalization process. In this section we present a composite indicator for each pillar based on available regional data. Each composite indicator is based on two sub-indicators, as shown in **figure 2.**

Figure 2: Pillars: essential elements



The indicators have been selected based on the literature review and on the availability of data. In fact each indicator makes use of (and is constrained by) the availability regional data. The indicators chosen are strongly linked to the different pillars and are believed to be very good proxy measures. **Table 1** gives an overview of the composite indicators and the constituting factors (sub-indicators).

Some of the measures used are derived from a set of indicators that has been developed by InnoMetrics and that is contained in the "Regional Innovation Scoreboard" (RIS) published in 2009, using mostly data from Eurostat at regional level for 2006.

Table 1: Input Factors, sub factors and data sources

Dimension	Indicators	Measure	Source
Institutions	Relative ranking of institutions' quality	Relative ranking of national institutions' quality	WEF – World Competitiveness Report
		Relative ranking of Regional institutions' quality	Quality of Government Institute – Mapping Quality of Government in the European Union: a Study of National and Sub-national variation
Intelligence	Life-long learning	Participation in lifelong learning per 100 population aged 25-64	RIS
	Tertiary Education	Population with tertiary education (ISCED 5-6) per population aged 25-64 per 100 population	RIS
Infrastructure	Broadband access	Share of households with broadband access	RIS
	Public R&D	Public R&D expenditures (GOVERD and HERD) as a % of GDP	RIS
Inspiration	Cultural employment High-tech employment	Reported employment in high-tech industries and cultural industries per 100 population	Own calculations from Eurostat data

Each dimension is measured by means of an indicator. Each indicator is the result of the combination of two measures. Data for each measure is collected mainly from Eurostat and RIS, the Regional Innovation Scoreboard and normalized with the min-max procedure (see "Normalization procedure" below). The two normalized measures are then multiplied and normalized to obtain the indicator, which is used as a proxy of the dimension.

Two indicators are used to assess the quality of institutions, one capturing the quality of national institutions and the second one the quality of regional institutions.

To create a relative ranking of institutions at national level data from the "Global Competitiveness Report" of the "World Economic Forum" was used. The "Global Competitiveness Index" classifies countries according to their relative performance with respect to the development of their institutions The ranking is based on objective data as well as on the results of a survey addressed to business leaders. According to the Forum "The role of institutions goes beyond the legal framework. Government attitudes toward markets and freedoms and the efficiency of its operations are also very important: excessive bureaucracy and red tape, overregulation, corruption, dishonesty in dealing with public contracts, lack of transparency and trustworthiness, and the political dependence of the judicial system impose significant economic costs to businesses and slow the process of economic

development. In addition, proper management of public finances is also critical to ensuring trust in the national business environment"10.

To assess the quality of institutions at regional level, data from a study of Charron, Dijkstra and Lapuente (2010) was used. In this study on the quality of Government, the authors map the variation of the quality of national and regional Governments in the 27 EU countries using a survey that involved about 34,000 EU residents. This study constitutes the largest multi-country survey on the quality of Government available at the regional level.

Intelligence is measured by the percentage of working population with tertiary education and the participation of the working population in life-long learning .

Inspiration is the pillar that measures the engagement of a region in creative and high-tech industries in line with the thinking of Richard Florida (2002). As a proxy for the creative class at regional level, regional employment in Arts, entertainment and recreation – the so-called "cultural employment" – and employment in high tech industries were combined in the composite measure.

In line with the definition of a technological infrastructure two indicators from the RIS (2009) dataset appeared particularly useful. The first s the level of public R&D spending reflecting to a large extent the money that goes to research labs in regionally based knowledge institutions. The second indicator is the share of households with broadband access as an indicator of the quality and scope of the communication network in the region.

Data on public R&D spending and broadband access are the only publically available at regional level. Although there are many more indicators that could be used as proxy of the quality of infrastructures, the two proposed here correlate strongly with the core elements of a smart innovation infrastructure.

Finally, all data have been normalized using the min-max procedure where the transformed score is first subtracted with the minimum score over all regions in and then divided by the difference between the maximum and minimum scores over all regions. The maximum normalized score is thus equal to 1 and the minimum normalized score is equal to 0. These normalized scores are then used to calculate the composite indicators as averages of the constituent sub-indicators.

[10] Schwab K. (2011) *The global competitiveness report 2010-2011.* World Economic Forum. pp. 4

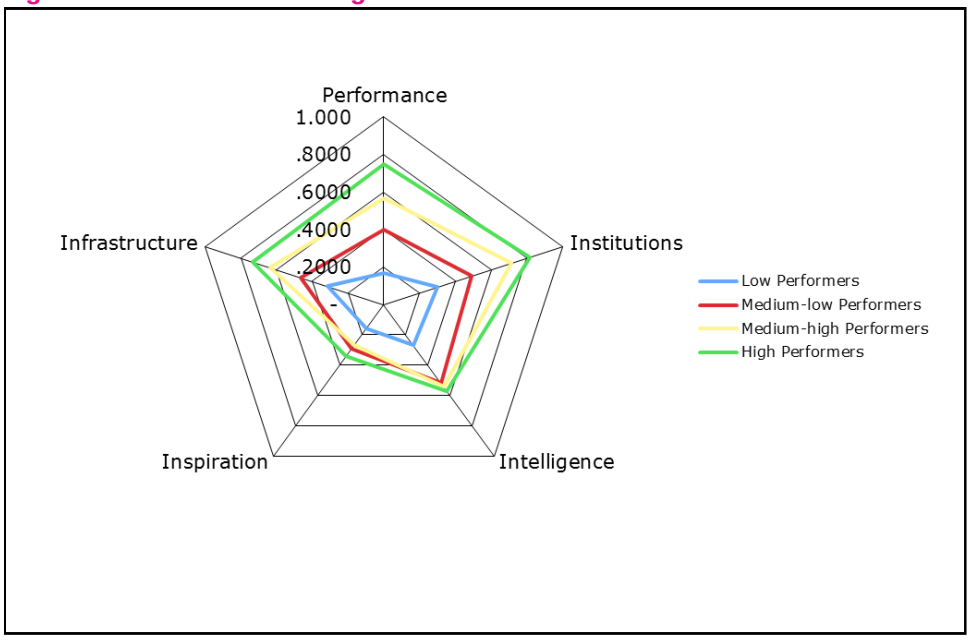
5 Do strong pillars lead to a better innovation performance?

The innovation performance of a region is measured by the number of EPO patents per million population. There has been some criticism with respect to the real accuracy of this measure in assessing the innovation performance[11] as it does not take into account differences across countries in economic costs and benefits of patents , and is sensitive to the kind of technology (some technologies need more protection) and type of firms (large firms showing higher patenting propensity). Despite these shortcomings, and in absence of other more accurate indicators it is still considered as the best available measure of innovation output (see Pavitt (1988), Hall et al, 2005).

Four performance types of innovative regions are defined following the quartiles of the regional patents distribution: low performers, medium-low performers, medium-high performers and high performers[12].

For each type, i.e. group of regions belonging to the different quartiles, the average innovation performance is calculated as wells as the average score for each of the creativity pillars. The plots of the average scores is shown in **figure 3**. The plot shows a strong relationship between performance and the four pillars. In fact the distance in innovation performance (serving as the yardstick on the vertical axis) between each of the groups is the same as the distance on the two pillars "institutions" and "infrastructure". This is less the case for "inspiration", where the differences between medium-low performers, medium-high performers and high performers are less marked. For "intelligence", medium-low performers, medium-high performers and high performers show more or less similar levels. Only the distance with low performers is very marked.

Figure 3: Performance of regions in different clusters



[11] J. Acs, Z. and Audretsch, D. B. (1989), *Patents as a Measure of Innovative Activity.* Kyklos, 42: 171–180.

[12] In this paper we focus on one of the three creative processes: innovation. Therefore here "performance" refers to the innovation performance of a region.

To investigate if the relationship holds systematically across all regions we analyzed the relationship between regional performance and the creativity pillars by means of a multivariate regression model. The model regresses regional performance against the four pillars for a set of 87 European regions (see list in the appendix).

Table 2: Regression results (figures in parenthesis represent standard errors)

	EPO patents		
	Regression (1) Coefficients	Regression (2) Coefficients	Regression (3) Coefficients
Institutions	0.399 (0.079)	0.382 (0.081)	0.481 (0.095)
Intelligence	- 0.073 (0.096)	0.127 (0.245)	0.113 (0.282)
Intelligence squared	--	- 0.204 (0.230)	- 0.296 (0.263)
Inspiration	0.449 (0.065)	0.440 (0.066)	0.258 (0.068)
Infrastructure	0.311 (0.108)	0.316 (0.108)	0.311 (0.125)
Constant	-0.088 (0.042)	- 0.117 (0.053)	- 0.020 (0.057)
R2	0.729	0.732	0.649

The first regression (1) shows that three out of the four pillars make a significant contribution to explaining regional innovation performance: institutions, inspiration and infrastructure.
The only surprise is that intelligence has a small negative but statistically insignificant coefficient. Two factors may account for this result. A first factor is the high correlation of intelligence with the three other pillars. The validity of this argument is supported by the correlation matrix (see **table 3**). **Table 3** shows that the variable intelligence is strongly correlated with both institutions and infrastructures. The fact that intelligence has not an extra effect in the regression might suggest that intelligence is not a sufficient but a necessary condition, and acts as a supporting factor for the development of the other pillars. It would also explain the lack of variation in this variable among the top and medium performing regions (see **figure 3**). The last suggestion finds support in recent literature (see e.g. Tebaldi and Elmslie, 2008). Another interesting finding from the correlation matrix in **table 3** is the weak correlation of the inspiration pillar with the other pillars. This gives this pillar a very specific and marked role in explaining innovative performance across regions.

Table 3: Correlation matrix

	Institutions	Intelligence	Infrastructure	Inspiration
Institutions	1.0000			
Intelligence	**0.6760**	1.0000		
Infrastructure	0.7844	**0.7782**	1.0000	
Inspiration	0.1373	**0.0289**	0.1142	1.0000

A second factor that might account for the insignificance of the intelligence factor could be the non-linearity in the relationship between education and innovation, suggesting that education plays only a more important role for the performance of less innovative regions. To test this argument, a second regression was run, adding the squared value of the “intelligence” variable as an extra regressor. The result of the second regression provide some support for the diminishing returns argument but the effect of “intelligence” remains small with large standard errors of the estimated coefficients.

Finally, in the first two regressions the composite indicator for the variable inspiration corresponded to the definition of the creative class where both employment in Arts, entertainment and recreation – the so-called “cultural employment” – and high-tech employment were included in the indicator. In order to assess whether this result is not only driven by thigh tech employment, the third regression (3) excludes high tech employment from the inspiration indicator. The proxy for the variable inspiration is solely represented by employment in Arts, entertainment and recreation in regression (3).

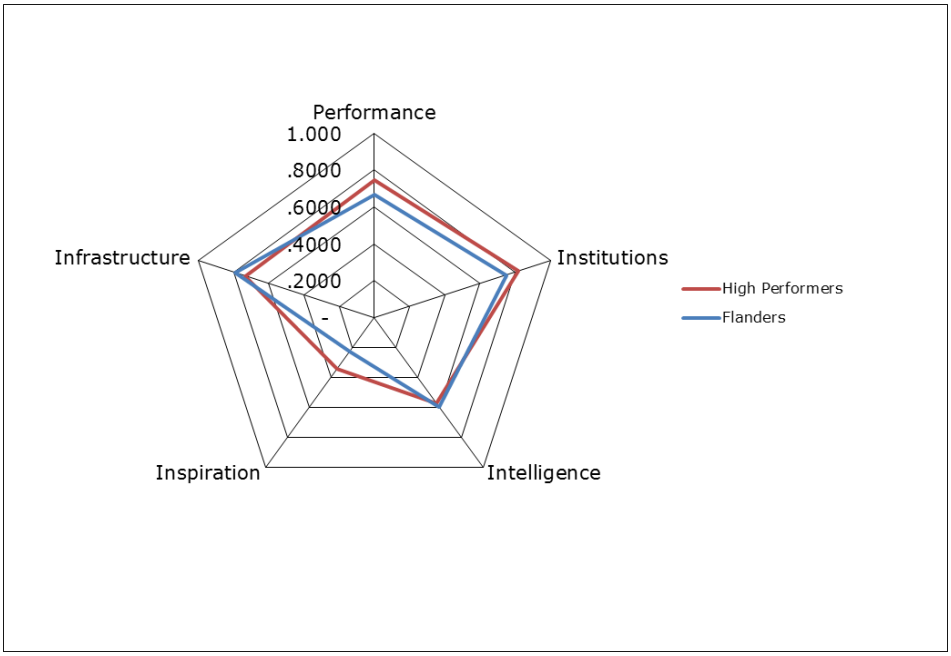
As shown in the last column of **table 2**, the model in which cultural employment is used as the sole proxy for the variable inspiration, the impact of the variable is still sizeable and the model has still a high explanatory power, supporting the hypothesis that the creative industries have a positive role in supporting the creative process of innovation that ultimately leads to economic growth.

One should also note that the goodness of fit of the regression model is high. Close to 75 per cent of the variation in innovation performance across the regions is explained by their scores on the different creativity pillars.

6 The position of Flanders

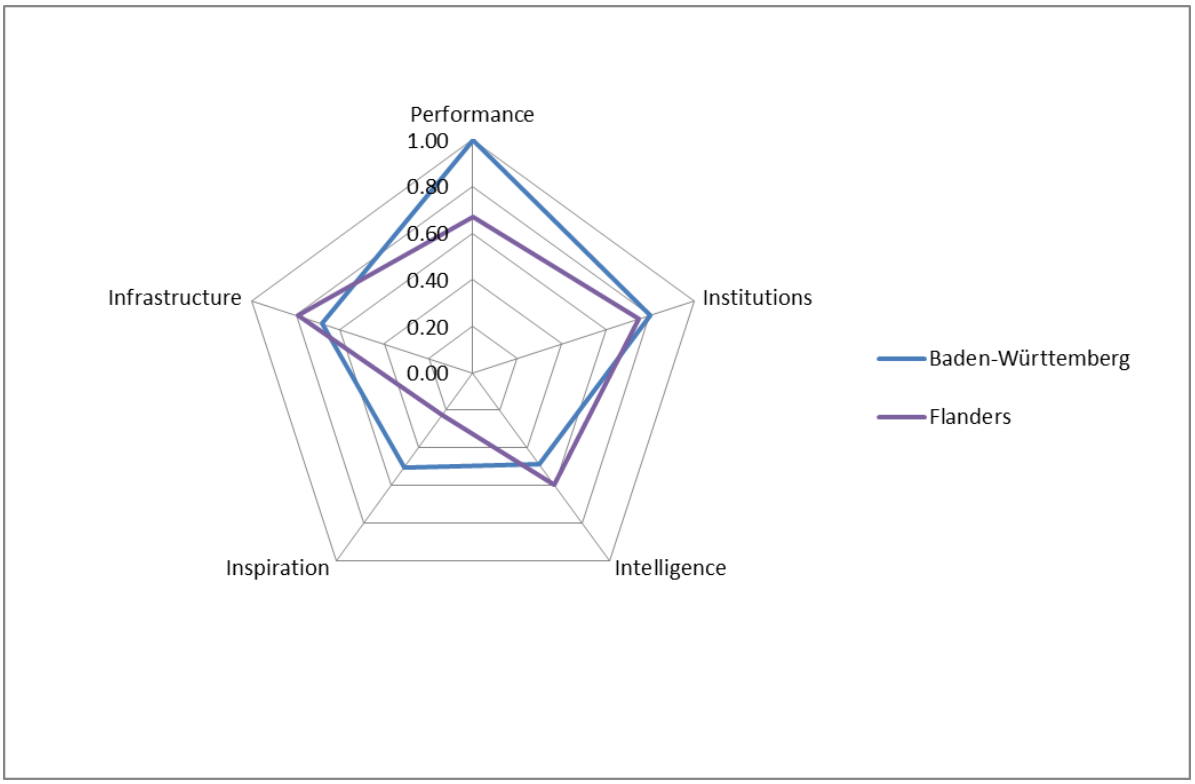
With the data available, we can assess the position of Flanders for innovation performance and the creativity pillars in comparison with other European regions. In terms of performance, Flanders is positioned in the upper part of the second quartile of the performance distribution. **Figure 4** shows the comparison between Flanders and the average of the group of high performing regions (upper quartile).

Figure 4: Performance of high-performing regions and Flanders



Compared to the average high performer, Flanders shows good results in terms of intelligence and infrastructures. The weaker performance of Flanders in comparison to the top regions in Europe is explained by its weaker institutions and its smaller creative class. **Figure 5** compares Flanders with the top performer, Baden Wurttemberg. Again, the weaker institutions and the weaker creative class account for most of the difference in terms of performance Both these pillars should therefore get due attention in the design and implementation of new innovation policies by the Flemish government and local authorities. However, as argued before, innovation cannot be the sole process to focus on and can also not be considered in isolation from the other creative processes of entrepreneurship and internationalization if the aim is to generate regional growth.

Figure 5: Performance of the top performer and Flanders



The next section analyses the interaction between the three creative processes by means of a case study for the subregion of Leuven.

7 Cluster formation in a creative innovative region: The case of Leuven

The previous section focused on the relationship between innovation performance and the creativity pillars. However, as emphasized before, for a superior performance of the region the three creative processes of entrepreneurship, innovation and internationalization need to interact and reinforce each other to generate economic growth. A formal modeling of these interactions is not straightforward. Unveiling how the interaction of the three different processes takes place can therefore best be done by means of a case study.
This section illustrates the interaction between the three creative processes for the case of the Leuven region, a dynamic fast growing region in Flanders, Belgium. The case shows how the three creative processes interact and generate clusters of related activities in selected technology areas. It also shows how this interaction is supported by the 4i pillars.

7.1 Leuven's innovation performance

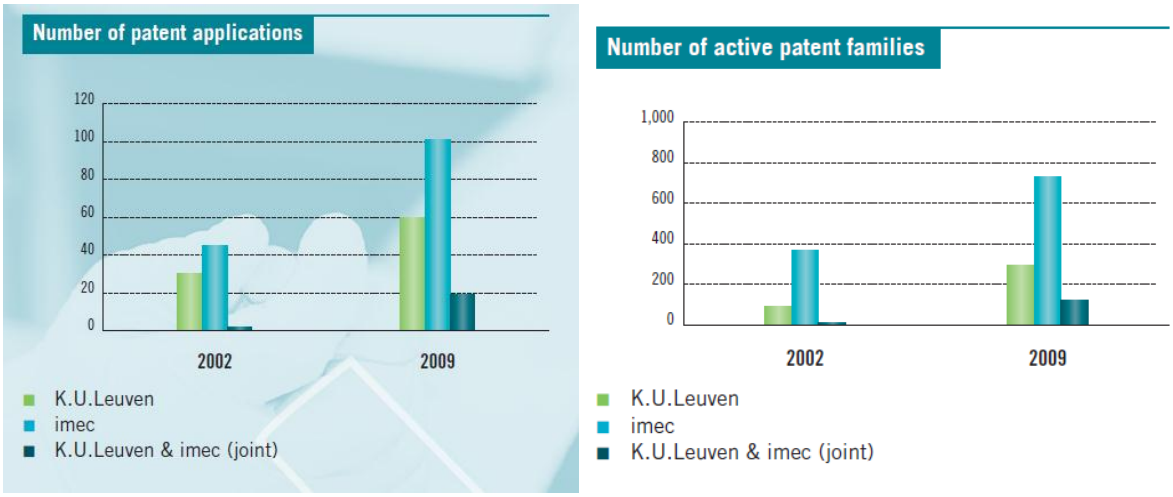
In the previous section the main ingredients of a creative innovative region were outlined and the fundamental role of its four basic pillars – institutions, intelligence, infrastructure and inspiration – was emphasized. An example of a creative innovative region showing a rapid development is the region of Leuven, in Flanders, Belgium. The Leuven region is a very good example of how innovation entrepreneurship and internationalization work together to generate regional growth, transforming knowledge into social and economic value, based on a solid combination of the 4i-pillars.

In the Leuven region itself, 6.2% of the population is employed in high tech knowledge intensive services, outing the region at the tenth place among all regions in the EU 15 (EU regional Statistical Yearbook, 2009) . The growth in this employment is to a large extent driven by the knowledge centers and spin-off companies in the region, but also by the investments done by foreign companies in the region. Important knowledge centers in the region are the Catholic University of Leuven (KULeuven), the university Hospitals and IMEC, the interdisciplinary research center on micro-electronics.

Inventors from the Leuven knowledge institutions have filed a growing number of patents, either separately or jointly. It is interesting to notice that also the number of active patents families[13] has increased in the past years, especially in the case of IMEC (see figures below). The increasing number of patents is the result of large investments in research and development and of the quality of the research performed by the various knowledge institutions and related companies.

[13] OECD defines a patent family as "a set of patents taken in various countries to protect a single invention (when a first application in a country - the priority - is then extended to other offices)." (OECD 2001 – Economic Analysis and Statistics Division, *OECD science, technology and industry scoreboard: towards a knowledge-based economy*).

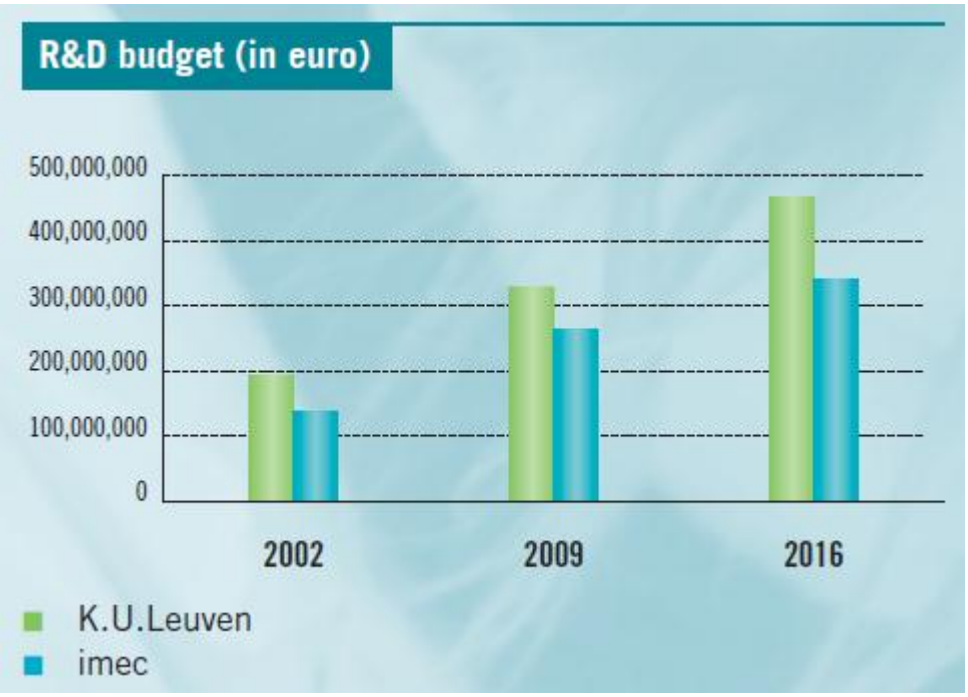
Figure 6: Evolution of patent application and active patent families (2002-2009)
(source: www.leuvenknowledgepearl.com)



The increasing number of patents of KU Leuven and IMEC has translated into an increasing number of spin-offs in the area. For the next five years the number of spin-offs generated is expected to growth by more than 25 per cent (see forecast for 2016 in **figure 7**). An increasing number of start-ups is generated as the result of the transfer of patented technology to industry.

Figure 7: Evolution of the number of spin-off companies (2002-2016)
(source: www.leuvenknowledgepearl.com)

Figure 8: Evolution of the R&D budget (2002-2016)
(source: www.leuvenknowledgepearl.com)

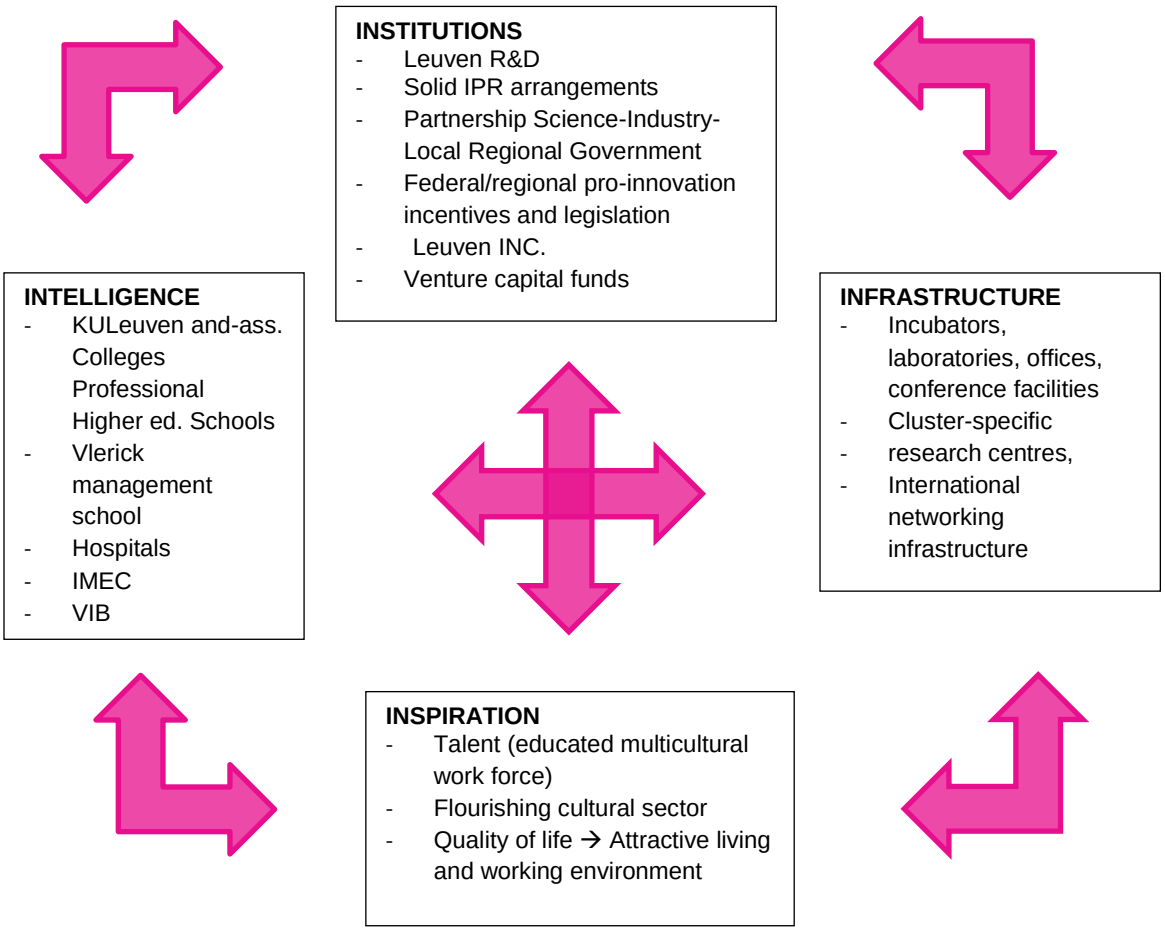


Between 2002 and 2009 the R&D budget has increased steadily for both KU Leuven and IMEC and it is projected to increase further between 2009 and 2016. The income generated by research collaboration is following the same path and is projected to reach about 270 million euros. While the knowledge basis of the region is wide and diverse, the emphasis on promoting excellence and valorization of inventions has led to the emergence of four strong world-class clusters of knowledge centers and new firms and multinational firms attracted to the region around major scientific themes.

7.2 Creativity pillars

The continuous flow from idea to innovation, high impact entrepreneurship and international growth is supported by the interplay of the 4i-pillars of basic conditions directing and stimulating the creative processes.
Figure 9 summarizes the 4i factors for the Leuven region.

Figure 9: The 4i in the Leuven region



The successful growth in new high tech firms, many of them spin-offs from knowledge centers, licensing agreements and clustering of new activities in the regions is strongly linked to the knowledge institutions present on the territory: the Catholic University of Leuven (KU Leuven) and its sub-departments, the Leuven University Hospitals, IMEC and the numerous departments of the Flemish Interuniversity institute for Biotechnology (VIB) that are located in Leuven. These organizations generate ideas, provide education and training and develop the basic research and they input it into the system. They provide both the research output that can then be developed by the industry and turned into marketable innovation, and the talent pool that is present in the area. In fact around 10% of the Leuven population is involved in academic research and knowledge development.

Leuven also offers a very attractive *inspirational* environment with a mix of talented professionals coming from all over the world and with a wide array of cultural events. Moreover, the presence of a large and internationally diverse student population, the high quality of life and the city safety make it an attractive living and working environment. Leuven has an extensive and multi-cultural student population of about 34 thousand students that translates into a highly educated multi-lingual workforce: 196 nationalities live and work in the Leuven area. This extensive pool of talent generates a large amount of new ideas ready to be translated into social and economic value. At the same time the city invested in an important cultural infrastructure, organizes top cultural events and, in collaboration with the academic (student) community, organizes progressive art events.

In the Leuven area the process of knowledge transfer between academia and the industry is actively supported by local *institutions*. An important supporting institution is Leuven R&D (LRD).
LRD was founded in 1972 and works as a technology transfer office, establishing a link between the universities and the business world to give both start-ups and established companies the legislative, technical and business advice to facilitate the knowledge transfer process from the knowledge institutions. LRD fulfills its mission through three main activities. First of all it helps setting up university-industry cooperation for contract research. Second, LRD is in charge of managing the intellectual property of KULeuven, supporting the process of patents application and giving advice on any other form of intellectual property protection. The third task of LRD is to support spin-offs. In this case LRD gives advice and support to companies that start their activity exploiting patents or other intellectual property that was developed by the knowledge institutions.
Another important support institution present in the Leuven area is IMEC. Founded in 1984, the IMEC "performs world-leading research in nanoelectronics." As explained on IMEC's website "we leverage our scientific knowledge with the innovative power of our global partnerships in ICT, healthcare and energy. We deliver industry-relevant technology solutions. In a unique high-tech environment, our international top-talent is committed to providing the building blocks for a better life in a sustainable environment.". The scope of IMEC research activities is rather broad, and for this reason it is a very active institution in all the region's clusters. IMEC does not only develop knowledge but also acts as a knowledge transfer platform. IMEC transfers knowledge in different ways: existing companies can enter licensing agreements with IMEC, while spin-offs that use new technology developed by IMEC get supported and encouraged. Over the past 20 years IMEC and LRD have made it possible for 85 spin-offs to start and grow through support, advice and knowledge transfer.
Another way to transfer technology is through people: each year around 15% of the IMEC staff transfers to the private sector, acting as a bridge between IMEC and the industry.
The presence of IMEC in the area has also an important *image* function. Thanks to its reputation as a centerpiece in knowledge creation in microelectronics in Europe IMEC attracts to the area R&D intensive companies that want to be closely located to this organization.
A second group of institutions are the so-called "networking institutions". An example of such an organization is Leuven Innovation and Networking Circle (Leuven Inc.). The role of this institution is to bring together innovation-minded people from both well-established companies and start-ups, venture capitalists and academia and to support them working together through networking. Among other things, networking allows start-ups to get in touch with venture capitalists. In fact it is very important that start-ups, and more generally innovation projects, get the adequate financial support. In the Leuven region there are not only private venture capital funds available, but also public funding and university funding. A strong institutional framework supports the interaction among firms and knowledge centers. In combination with private venture capital organizations, IMEC and KU Leuven support entrepreneurship by offering various kinds of financing facilities and private equity deals.

The Leuven area does not only have strong knowledge institutes, but also provides innovators with high-quality *infrastructures*. Both facilities and transportation infrastructures are highly developed. Leuven is located at the heart of Europe, only few kilometers away from Brussels, the European capital. The international airport is located very close to Leuven and the area offers efficient train connections and it is not far from the Antwerp harbor. From the facilities perspective, Leuven offers state-of-the-art incubators, where laboratories and offices are available for both spin-offs and existing companies. High market risk and low capitalization make it make it often difficult for start-ups to invest in real estate and infrastructures. The Haasrode research park, Science Park Arenberg, the Innovation and Incubator Centre (I&I) and the Termuk science park are only some examples of the infrastructures available. The region has also one of the most advanced telecommunications infrastructure with extensive broadband facilities.

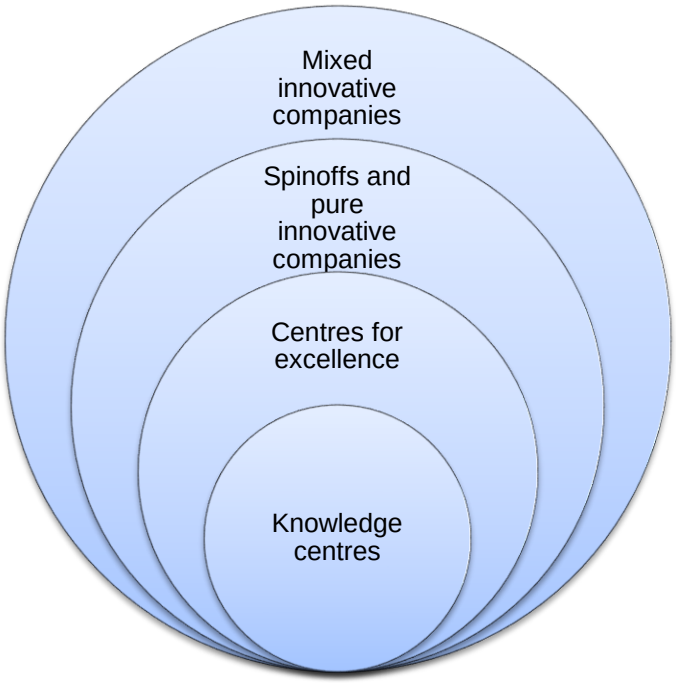
The combination of institutions, intelligence, infrastructure and inspiration not only develops talent and innovative companies but also triggers a virtual circle in which more hi-tech companies and talented people are attracted to the region. The triple helix collaboration among institutions, academia and

companies helps shaping the image of the Leuven region as an attractive area for innovation. However, as is true for most universities and regions, through the years there has been an evolution towards a strong concentration of patented inventions in a restricted number of technology domains. The clear concentration of patents in a number of technology domains goes together with a physical concentration of enterprises active in the same domains clustering around Leuven.

7.3 Cluster formation as the result of system interaction between the creative processes

The process of knowledge transfer and specialization through the years has led to the emergence of technology-based clusters in which the three creative processes innovation, entrepreneurship and internationalization strongly interact.

Figure 10: Clusters' layers in the Leuven region[14]



The clustering follows a dynamic growth process which typically starts from basic knowledge development. The knowledge institutes are incentivized to generate new ideas and guarantee a continuous stream of knowledge. Similar to a growing pearl this process leads to the development of centers of excellence in which ideas get further processed into applied knowledge. This knowledge is passed on to the companies that translate it into marketable innovation. Networking and liaison organizations support the knowledge transfer process in different ways, including licensing to existing companies, partnerships with international companies, and a growing number of spin-off companies. Other ways to transfer knowledge is through human resources, or through the development of joint projects by the research institutes and industrial companies.

Strong clusters in the Leuven region are life sciences, feed-food-health, mechatronics, telematics & communication, e-security and microelectronics & nanotechnology.

[14] See Annex 2 for a complete list of clusters' actors

A first important cluster is built around life science. The cluster takes its main impulse from the Leuven University hospitals and faculties of medicine and, biology forming the Health Science campus. This campus brings together education, research and medical care, enabling the development of synergies and knowledge spillovers. An example of the great achievements of the research at the Health Sciences campus is Viread, the most used anti-HIV agent in the world, discovered in 1993.

Next to the hospital, a clinical trial center was developed. This center is in charge of the coordination of clinical trials. The infrastructure supporting the development of science and research into innovation manifests itself in two other centers. The Centre for medical innovation (CMI) aims at establishing an integrated biobank, promoting translational research and support spin-offs. It is co-funded by the Leuven hospitals, the Flemish Government and pharmaceutical and biotech Industries. The Centre for Drug Design and Discovery (CD3), is a technology transfer platform funded by the KULeuven and capital from the EU investment fund. This organization aims at developing new drugs to the stage where pharmaceutical and biotech industries can use them. Knowledge transfer is then obtained through licensing, project partnerships, and spin-offs. Some examples of successful spin-offs are Thrombogenics for biopharma drugs, TiGenix for joints medication and reMYND for Alzheimer medications.
The success of the cluster is made by a strong supporting *institutional* framework. In clinical trials, for example, the excellence is not only driven by the presence of a clinical trial center, but also by the fact that the approval procedure for clinical trial has been made fast and efficient.
The *infrastructures* available in this cluster are very advanced and dedicated. The Bio incubator is an environment in which both entrepreneurial start-ups and existing companies can develop ideas into innovations thanks to state of the art laboratories and office spaces. The main aim of this incubator is to bring together education, R&D and medical care and to foster cooperation among the three. The success of this incubator was followed by a second and a third one that is currently under construction, based on an expansion plan worth about 800 million euros. As a result, an increasing number of global companies active in this sector have been locating their offices and operations in the Leuven area.
Companies are interested in working together with the knowledge institutions to develop new marketable solutions in health care. Collaboration and networking are clearly at the hearth of the success of this cluster. This collaboration does not only include public-private partnerships, but also interdisciplinary research initiatives, which are strongly encouraged inside the network. An example of this is the Leuven Medical Technology Centre (L-MTC), which brings together 41 research groups and 700 researchers and academics from the domains of engineering and biomedical sciences to develop new solutions in fields like medical imaging, healthcare automation and biomonitoring. Another example of successful collaboration among different research domains is Neuroelectronic Research Flanders (NERF). NERF is a joint initiative of KU Leuven, VIB and IMEC and aims at combining nanoelectronics with neurobiology to develop the basic research that is necessary for studying pathologies like Alzheimer.

A second major cluster is based on nanotechnology. This cluster received its main impulse from IMEC. Since it was founded in 1984, IMEC has grown to becoming a global player in nanoelectronics research. The applications of IMEC's research can be found in the most diverse industries making it a very important player in Leuven's innovation system. Throughout the years a research platform developed around IMEC, bringing together top international companies in integrated circuit and microelectronics like Panasonic and Intel. The business model of the research platform is based on open innovation and interdisciplinary research, in line with the other clusters. The Leuven Nanotechnology Research Centre (LNANO), for example, is an umbrella organization for 26 research groups on nanoscience and nanotechnology. Another example is the Leuven Materials and Research Centre (Leuven-MRC), which integrates nanotechnology with materials' development. It brings together a large group of university academics and researchers working on nanocomposites, biopolymers, materials for sensors and micromanufacturing, nanostructured steels and ceramics. Research and education in the field is also provided by two departments of KU Leuven, the

Department of Metallurgy and Material Engineering (KUL-MTM) funded in 1930 and the Department of Electrical Engineering (KUL-ESAT), founded in 1900.
Similar to the life science cluster the support of the Flemish Government is central and helps developing collaboration and technology transfer. The Strategic Initiative Material (SIM), for example, is a very recent initiative for the production of new materials with very different applications and is the result of the joint efforts of Agoria Flanders, Sirris, and the five Flemish universities, with the support of the Flemish Government.
Thanks to the international reputation of knowledge institutions such as KU Leuven and IMEC, many international companies have decided to locate their operations in the Leuven area. Moreover many spin-off companies were born as the result of the exploitation of ground-breaking technology developed at IMEC. The presence of this institution on the territory does not only foster innovation but also various forms of high tech entrepreneurship. The nanotechnology clusters can count on state-of-the-art clean room facilities.

A third cluster is based on mechatronics and smart systems. This cluster develops around three main departments of KU Leuven: the division of production engineering, manufacture design and automation (PMA), the department of electrical engineering (ESAT) and the department of computer science. Leuven Measurement Systems (LMS International), which today is the world leader in computer aided dynamic analysis was the first spin-off that emerged from this cluster.. Many other spin-offs have been created since then, placing Leuven on the map of the international mechatronic research and product development. The mechatronic cluster accounts today for half of the spin-off employment of the Leuven area, with an headcount of 3.600 people. Technology transfer to these spin-offs and to existing companies is made possible by the supporting institutions, like Flanders' Mechatronic Technology Centre (FMTC). This research center aims at linking academic research in the field of mechatronics with the needs of the industry, helping research becoming innovation that can be commercialized. In line with the other clusters, FMTC has the support of the Flemish Government and cooperates with the other knowledge centers in the cluster, such as the PMA (Production engineering, Machine design and Automation) division of KU Leuven.
Another support center is the Leuven Centre for Information and Communication Technology (LICT). While FMTC focuses on mechatronics, LICT focuses on smart systems. This center aims at fostering multidisciplinary research among a pool of university academics and researchers in the fields of electronic engineering, computer science and sociology. The same support to multidisciplinary research is given by the Institute for Broadband Technology (IBBT) and Leaders in Security (LSEC). The first one was founded by the Flemish Government to stimulate innovation in ICT, while the second brings together companies with expertise in electronic security.
All these centers play a double role in this cluster. They do not only act as multidisciplinary research platforms, but also as a magnet that attracts the most important international players in the fields of mechatronics and smart systems, helping to build the strong identity of the Leuven area. Another important reason why companies in the fields of mechatronics and smart systems locate in the Leuven area is the highly advanced infrastructure available. The Arenberg Science Park that was built in 2004 offers 126.000 square meters of office spaces and state-of-the-art laboratories. The Innovation and Incubation Centre (I&I) of KU Leuven is an incubator for mechatronics companies with facilities for prototyping and small-scale production.

The fourth cluster is built around clean-tech. Companies active in this cluster focus on solar cells manufacturing, over advanced process control, rapid product development for power electronics, the development of light weight structures and materials for windmills, water and waste treatment and fuel efficiency. This cluster is of more recent origin, but is developing quite fast, thanks to the support of the Flemish Government and Capricorn Venture Partners, a venture capital fund located in Leuven. The Capricorn Cleantech Fund is specialized in financing European cleantech companies.
Interdisciplinary research is also key in this cluster. The Leuven Sustainable Earth (LSUE) initiative by the KULeuven consists of 25 research groups in very diverse areas ranging from environmental sciences to economics and from engineering to sociology and law work together to find solutions for

the sustainable use of resources, such as energy and food, and to study global phenomena such as climate change and the human impact on biodiversity. The Leuven Material and Research Centre (Leuven MRC) coordinates most of the research in the different areas.

From the analysis of the four clusters it is clear that in the Leuven region the three processes of innovation, entrepreneurship and internationalization work together to generate sustainable development. The intelligence that flows in the system from the knowledge institutions and that gets applied by established companies or by entrepreneurial start-ups generates continuous innovation and attracts innovative and hi-tech multinational companies to the region. The interaction triggers a virtuous circle in which more knowledge is spread and transferred, more innovation is generated, more spin-offs are born, fastly growing into international companies and multinational firms are attracted to the region.

This process would not be possible without the strong underlying support of the contextual conditions, the 4is. Without adequate intelligence that guarantees a flow of knowledge and that supplies highly qualified human resources, strong institutional support including venture capital funds, state-of-the-art infrastructures and an attractive inspirational environment the process would neither be possible nor sustainable.

7.4 Scaling up the clusters: the interregional ELAt network

The Leuven clusters, while geographically concentrated, are not isolated from similar cluster developments in in other European and non-European regions. In fact there is a close connection with clusters centered around the same technological families in regions geographically close to Leuven, in particular Eindhoven (Netherlands) and Aachen (Germany). The networking and co-operation among these regions has been intensified in the last couple of years with the aim of establishing a cross-border Top Technology Region, ELAt, with a size comparable to the leading technology regions in the world.

Figure 11: The ELAt network (source: http://www.elat.org/)

The ELAt (Eindhoven Leuven Aachen technology region) region has an area of 14,269 square kilometers and a population of 5.9 million people of which 2.9 billion constitute the available workforce. The aggregate GDP in 2005 was of 157.5 billion euros, 20% of which was generated by knowledge-intensive industries, which do not only generate growth themselves, but also drive the growth of other industries, creating a multiplier effect on the economy.
R&D expenditures in the ELAt region were close to 4 billion, or 2.5% of ELAt's GDP in 2005.

Similar to the developments in the Leuven region, ELAt can count on strong contextual factors: intelligence, institutions, infrastructures and inspiration.
Intelligence in the ELAt area is provided by the top knowledge institutions including the KU Leuven, the Eindhoven University of Technology and RWTH (Rheinland Westfalen Technische Hochschule). The area can also count on many internationally renowned research centers, like IMEC in Leuven, TNO in Eindhoven and the three Fraunhofer institutes in Aachen. In addition to the mentioned knowledge institutions, there are more than 20 other universities, business schools and polytechnics in the area.

Institutional support to knowledge creation is guaranteed by well-developed supporting institutions, a supportive Government's policy and a large set of financial instruments, like venture and seed capital. Innovative companies can count on state-of-the-art infrastructures. Incubators, research parks and

industrial parks are largely present in the ELAt region. An example are the I&I and biotech incubator in Leuven, the Haasrode research Park, the Arenberg Research Park, the DSM Chemelot research park in Geleen (Sittard), the High Tech Campus in Eindhoven (HTCE) and the incubators on the HTCE and the TU/e campus, the TZA and MTZ incubators, research and business parks in Aachen and the Avantis cross-border business park. Intelligence, institutions, infrastructures and a lively inspirational environment support the entrepreneurship-internationalization-innovation process in the ELAt region similar to the development in Leuven with many spin-off companies and international companies present in the three subregions. The growing co-operation between the regions is meant to build a sustainable global top technology region at a scale large enough to survive and compete with other large scale technology regions in the world.

8 Policy implications

By illustrating the role and the foundations or pillars of the three creative processes innovation, entrepreneurship and internationalization, this study offers some interesting insights about the effectiveness of regional policy. By establishing a system view centered on the interaction between the three creative processes of innovation, entrepreneurship and internationalization, proactive policies should focus on the development of the four fundamental pillars underlying these processes and their interaction. A good understanding of the impact of each of the pillars: institutions, intelligence, inspiration and infrastructure on the creative processes of entrepreneurship, innovation and internationalization is key in the design of supporting policies for the development of fast growing clusters. In this study the focus was on innovation, but in studying its impact on economic growth, the process of innovation should be seen in combination and interaction with the other two creative processes: impact entrepreneurship and internationalization. For each of these processes, different elements of the 4i will be important.

By comparing the region's performance with top Innovative regions in the EU and by analyzing the associated scores on the creativity pillars the study offers guidance to policy makers in what area improvements can and should be made. The results also suggested that education is a necessary condition for the well-functioning of the regional innovation system but apparently not a sufficient condition. A remarkable finding was the significant role of inspiration for the innovation performance of a region. Interestingly this variable shows substantial variation across the regions and is the least correlated pillar with the other pillars. The results is in line with the growing emphasis policy makers are putting on the development of creative industries (e.g. green paper on creative industries in the EU) Creative industries flourish at the local and regional level, and are in a strategic position to link creativity and innovation. They are instrumental in stimulating new ideas and activities, have important spill-over effects on other industries and enhance the attractiveness of regions and cities. They are often catalysts for structural change in mature industrial zones and help to adopt new technologies and ways of thinking that have the potential to develop in new business models. They should therefore be integrated into the regional development strategy and ensure an effective partnership between civil society, businesses and public authorities at the regional, national and European levels.

The comparison of Flanders with top Innovative regions in the EU singled out two pillars where Flanders should make improvements to foster innovation: institutions and inspiration. First, from an institutional point of view, according to the underlying data on individual items making up the institutions construct, a reduction of human capital taxation and an enlarged support to protect intellectual property rights, appear as crucial elements to improve the innovation potential of the region. These conditions are also extremely instrumental to stimulate SME's participation in the innovation process. With respect to the other weak pillar – inspiration – Flanders lags behind in jobs created in high tech activities. While this is true for the region of Flanders as a whole, there is important variation with respect to this pillar across sub-regions, as illustrated in the last section of the report.

The last section of the report analyzed the role of the different creativity pillars for the case of the Leuven region, and the extension to the ELAT region. Leuven is an exemplary region where the triple helix actors – policy makers, academic institutions and business – are working closely together in developing a top technology region centered around clusters in a selected class of General Purpose Technologies. The choice for becoming a technology top region for a selected number of technology domains fits very well with the concept of smart specialization that has recently gained great attention in EU industrial and regional policies (Foray, David, Hall, 2009). The core of the smart specialization

strategies consists in encouraging investment in programs that complement the region's other productive assets to create future capabilities and interregional comparative advantage.
Smart specialization is meant to create a differentiated competitive position of the region and to avoid that each region imitates and duplicates R&D and educational investment programs. On a wider basis, regions should benefit from complementarities with other regions. Smart specialization strategies should not be top-down strategies where policymakers make the choice of the technology domains to be de developed. The entrepreneurial process of discovery should reveal what a country or region does best in terms of science and technology, and innovations should be adapted to local skills, materials, environmental conditions and market access conditions. The cluster formation in the Leuven region illustrates this process very well, observing that especially academic entrepreneurship has been playing a key role in the process.

Clearly, not all sub-regions in Flanders can be technology leader. Many sub-regions of Flanders will have to go for a follower smart specialization strategy and invest in the development of the applications of a general purpose technology in one or several important economic domains of the regional economy. This may best happen in close collaboration with networks spanning regional and cross-regional borers.
Examples would be biotechnology applied to the development of new drugs or nanotechnology applied to agricultural and food products. Intelligence, infrastructure and inspiration should in these cases constitute "co-specialized assets" to create innovations in the follower regions. In order to stimulate this process governments should support the provision of adequate infrastructure and human capital formation to meet the new "knowledge needs" of traditional industries, i.e. helping to build absorptive capacity and to benefit from the newest developments in general purpose technologies.

Whether a technology leader or follower, the idea of smart specialization strategies asks for a careful interpretation of the dynamics of the different regions, and a search for complementarities, not of similarities with other regions. Policy makers should therefore best simplify and critically assess their policies and support measures in light of smart specialization strategies and look for maximal synergies with funding sources and research and innovation efforts in the different regions across Europe.

Within this regard, EU policies and infrastructure, including the European Institute of Innovation and Technology, should be maximally integrated within the development of regional industrial policies. Education, training and lifelong learning, as referred to in the Europe 2020 flagship "Youth on the Move" and in the "New skills for new jobs", offer other possibilities to leverage the regional's intellectual and inspirational assets. In order to better link the inspiration pillar with the intellectual pillar of the region, school, vocational and higher education curricula should increasingly focus on transversal competences in linking creativity with entrepreneurship, innovation and internationalization, an initiative that is gaining attention in the ERDF (European Regional Development Fund). The EU Commission services are exploring, with Member States and regional authorities, how co-funded programs can provide complementary financial support to FP7 for the construction of research infrastructure , and how a better benchmarking of good practices can be developed. With respect to infrastructure, the Commission has recently produced a "Smart Guide to Innovation-Based Incubators" for regional policy makers. The Enterprise Europe Network promotes SME participation in FP7 and CIP projects and fosters technology transfer and business partnerships. The Network helps companies to get connected to trans-national innovation and knowledge networks and increases the capacity of local and regional partner organizations to offer support services adapted to global value chains.
Support for transnational programs (e.g. the Baltic Sea Strategy) and inter-regional cooperation (e.g. FP7 Regions of Knowledge, CIP cluster initiatives and INTERREG IVC and URBACT, including the Regions for Economic Change initiative) stimulates and helps regions to participate and learn from high level interregional research networks emphasizing excellence.

In sum, effective and efficient regional policies should be based on a good understanding of the regional dynamics and maximally exploit synergies with other regions in building interregional networks of knowledge generation and exploitation.

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Annex 1 – List of actors in each cluster of the Leuven region

1 - Cluster Life Science
- Knowledge centres: KU Leuven
- Centres for excellence:
  - University hospital K.U. Leuven
  - Rega Institute: CEHA Laboratory Of Experimental Genetics and Transgenese
  - VIB: VIGOUR
- Pure innovative companies:
  - 4 AZA Biosciences
  - @Medical Techn.
  - Algonomics
  - Cochlear
  - Custom8
  - Dakocytomation
  - Data4S
  - Materialise
  - Medicim
  - M-Elect
  - MXS
  - New Standard Eng.
  - PharmaDM
  - PatientWeb
  - QMedit
  - reMYND
  - RNA-Tech
  - Tigenix
  - Thromb-X
  - Vivactiss
- Mixed innovative companies:
  - Autocyte Europe
  - Biotest Seralco Benelux
  - Centocor
  - Conti BPC
  - Dermat
  - E.S.R.I. Deckers Div
  - IVIA
  - Malaise&co
  - Medvision Benelux
  - Norgine
  - Ortec
  - Terumo Europe
  - VWR International

2 – Cluster Nanotechnology:
- Knowledge centres:
  - K.U. Leuven
  - IMEC
- Centres of excellence
  - IMEC: Design Platform – Nanotechnology Platform Sub-45nm research facility
  - K.U. Leuven: Lab of solid-state physics and magnetism – Lab photochemistery and spectroscopy
- Pure innovative companies:
  - Agilent Techn.
  - AnSern
  - ARM
  - ASM Belgium
  - Cypress Semi
  - CoWare
  - Easics

        - Eonic Systems
        - Epiq Sensor Nite
        - FillFactory
        - ICOS Vision Systems
        - JSR Electronics
        - J.W. Lemmens
        - Newfrom
        - Oligosense
        - Option International
        - Philips ITCL
        - Photovoltech
        - Resonext
        - Seprentrio
        - Soltech
        - STM
        - Taget Compiler Techn.
        - Vector International
        - Vivactiss
        - Xenics
    - Mixed innovative companies:
        - A.C.S. Belgium
        - Assurcard
        - B.E.S.T.
        - Data4S
        - Delcomp
        - Eyetronics
        - IPCOS
        - Krypton
        - LMS
        - Luciad
        - MicroMatic
        - Mind Linux Solutions
        - Telindus
        - Tomoton
        - Tyco Electronics

3 – Cluster Mechatronics

- Knowledge Centres: K.U. Leuven
- Centres of excellence:
    - FMTC
    - K.U. Leuven: Department Mechanics research groups – Department of Metallurgy and materials engineering – laboratory of agricultural machinery and proc.
- Pure innovative companies:
    - Atos engineering
    - Barco Aarschot
    - D2S international
    - Electrical and mechanical design
    - DV consultinf
    - IPCOS
    - Entecom Systems
    - Krypton
    - LMS
    - Luyten Automation
    - Materialise
    - Metris Somatech
    - M&M corporation
    - Data analysis products
    - CSI
    - Optidrive
    - PEC EME
    - Scala Consultants

    - WTCM
    - Air Beraing Prec. Techn
- Mixed innovative companies:
    - ACE Electronics
    - Affilips
    - Alnaco
    - Camco Techn
    - Donaldson
    - Dynamotor Decoster
    - Flexlink Systems
    - Ora Machines
    - B.E.S.T.
    - Partec Eng
    - Robert Bosch
    - South Lancs Belgium
    - SST Food Mach.
    - Stas
    - Tecmate Intl.

Annex 2 – List of regions in alphabetical order

Alföld és Észak
Baden-Württemberg
Bassin Parisien
Bayern
Berlin
Brandenburg
Bremen
Canarias (ES)
Centre-Est (FR)
Centro (ES)
Centro (IT)
Ceská republika
Comunidad de Madrid
Continente
Danmark
Dunántúl
East Midlands (UK)
East of England
Eesti
Éire/Ireland
Est (FR)
Este (ES)
Hamburg
Hessen
Île de France
Isole
Közép-Magyarország
Kypros/Kibris
Latvija
Lietuva
London
Macroregiunea doi
Macroregiunea patru
Macroregiunea trei
Macroregiunea unu
Manner-Suomi
Mecklenburg-Vorpommern
Méditerranée
Niedersachsen
Noord-Nederland
Nord - Pas-de-Calais
Nord-Est
Nord-Ovest
Nordrhein-Westfalen
Noreste (ES)
Noroeste (ES)
North East (UK)
North West (UK)
Northern Ireland (UK)
Oost-Nederland
Ostösterreich
Östra Sverige
Ouest (FR)
Região Autónoma da Madeira (PT)
Região Autónoma dos Açores (PT)
Region Centralny
"Région de Bruxelles-Capitale /
Brussels Hoofdstedelijk Gewest"

Region Pólnocno-Zachodni
Region Pólnocny
Region Poludniowo-Zachodni
Region Poludniowy
Région wallonne
Region Wschodni
Rheinland-Pfalz
Saarland
Sachsen
Sachsen-Anhalt
Schleswig-Holstein
Scotland
Severna i iztochna Bulgaria
Slovenská republika
Södra Sverige
South East (UK)
South West (UK)
Sud
Südösterreich
Sud-Ouest (FR)
Sur (ES)
Thüringen
Vlaams Gewest
Wales
West Midlands (UK)
West-Nederland
Westösterreich
Yorkshire and The Humber
Yugozapadna i yuzhna tsentralna Bulgaria
Zuid-Nederland

Annex 3 – Descriptive statistics

	Mean	Standard deviation	Median
Performance	0.47	0.22	0.49
Institutions	0.58	0.27	0.70
Intelligence	0.47	0.22	0.48
Inspiration	0.26	0.23	0.18
Infrastructure	0.53	0.23	0.55

Knowledge Partner

ISBN-NUMMER: 9789078858836
D/2011/11.885/02